UNCLASSIFIED

AD NUMBER

AD819625

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited.

FROM:

Distribution authorized to U.S. Gov't. agencies and their contractors; Critical Technology; AUG 1967. Other requests shall be referred to Air Force Office of Scientific Research, SRGL, Bolling AFB, DC. This document contains export-controlled technical data.

AUTHORITY

afosr ltr, 12 nov 1971

THIS PAGE IS UNCLASSIFIED

AD819625

AD819625

AFOSR 67-2029

University of Utah

Department of Chemical Engineering

Final Summary Report

on

COMBUSTION IRREGULARITIES OF SOLID PROPELLANTS

Grant AF AFOSR 446-65

October 1, 1965, to September 30, 1966

2. This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of AFOSR (SRGL).

Salt Lake City, Utah

UNIVERSITY OF UTAH

DEPARTMENT OF CHEMICAL ENGINEERING

Final Summary Report

on

COMBUSTION IRREGULARITIES OF SOLID PROPELLANTS

Grant AF AFOSR 446-65

October 1, 1965, to September 30, 1966

Date Submitted: August 1, 1967

Report Prepared by:

Norman W. Ryan

Norman W. Ryan
Principal Investigator

INTRODUCTION

This report summarizes activities under AFOSR Grant 446-65, for the period 1 October, 1965, to 30 September, 1966. The project, titled "Combustion Irregularities of Solid Propellants," was under the technical monitorship of Dr. B. T. Wolfson, AFOSR Office of Aerospace Research.

The research performed was an extension of that previously done under the same sponsorship. From the point of view of the Air Force, the continued efforts have contributed techniques for determining (and testing analytical descriptions of) those propellant combustion irregularities that are of critical concern in the performance of rocket-powered missiles.

SUMMARY

In the period of Grant AF AFOSR 446-63, of which the grant here discussed was a continuation, two principal objectives were attained:

1. investigation in depth of certain operating characteristics of the T-burner and

2. development of a perliminary theory of L^* instability, treating it as self-excited oscillatory combustion and correlating the nonacoustic instability of a class of PBAA/AP propellants by means of the theory.

Starting from the natural node in the cycle of producing publishable results, the work under the subject grant consisted largely of early stages of developing a new type of burner for studying acoustic instability and of formulating a more general version of the theory of nonacoustic instability. Both efforts are still proceeding under a further continuation, Grant AF AFOSR 446-66.

The burner for studying acoustic instability is the cylindrical, side-vented chamber burning premixed gases introduced through a permeable frit in one end. This variant of the T-burner, employing a simpler and more easily controlled combustion system than solid propellant, will allow observation of some effects of oscillatory combustion under precisely determined conditions. Furthermore, it should provide a tool for evaluating the susceptibility to pressure-coupled instability of propellants too stable to test in the conventional T-burner.

The conceptual simplicity of the gas-fired burner is deceptive.

Two problems, more severe than anticipated and under continuing study, are to determine the acoustic admittance of the frit and to minimize chamber-coupled pressure and composition transients in the gas feed system.

Additional data have been obtained with the low L^* burner to support the observations of Beckstead [1], but the chief effort related to nonacoustic instability has been to complete the theory. There has evolved a modular theory of instability, of which Beckstead's is a special case, from which one can, in principle, obtain characteristic equations for oscillation frequency and growth constant. To the present, principle has not been reduced to practice, except for special cases.

PUBLICATIONS AND PRESENTATIONS

JOURNALS:

[1] Beckstead, M. W., N. W. Ryan, and A. D. Baer, "Nonacoustic Instability of Composite Propellant Combustion," *AIAA Journal*, *4*, 1622 (1966).

PRESENTATIONS AND OTHER RELATED ACTIVITY OF PRINCIPAL INVESTIGATORS:

Presentations to and session chairman, 2nd ICRPG Combustion Conference, Los Angeles, 1965.

Discussant, papers presented at AIAA 2nd Propulsion Joint Specialists Conference, Colorado Springs, 1966.

Presentations at AFOSR Contractors' Meeting, Palo Alto, 1966.